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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

INTERNATIONAL APPLICATION NO.
PCT/DE00/01787

INTERNATIONAL FILING DATE
31 May 2000

PRIORITY DATE CLAIMED
3 September 1999

TITLE OF INVENTION

METHOD FOR DETECTING AND EVALUATING WORD SPEECH SIGNALS REPRESENTING A
WORD FROM A USER OF A SPEECH RECOGNITION SYSTEM

APPLICANT(S) FOR DO/EO/US

Josef BAUER et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☒ This is an express request to immediately begin national examination procedures (35 U.S.C. 371(f)).
3. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
4. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
5. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
6. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
7. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
8. ☒ An oath or declaration of the inventor (35 U.S.C. 371(c)(4)).
9. ☒ A translation of the Annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 10-15 below concern document(s) or information included:

10. ☒ An Information Disclosure Statement Under 37 CFR 1.97 and 1.98.
11. ☒ An assignment document for recording.
Please mail the recorded assignment document to:
 - a. ☒ the person whose signature, name & address appears at the bottom of this document.
 - b. ☐ the following:
12. ☒ A preliminary amendment.
13. ☒ A substitute specification
14. ☐ A change of power of attorney and/or address letter.
15. ☒ Other items or information:

Copies of PCT-EASY forms filed with International Application, cover page of International Application as published, International Search Report, and International Preliminary Examination Report.

☒ The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees as follows:

| CLAIMS | (1) FOR | (2) NUMBER FILED | (3) NUMBER EXTRA | (4) RATE | (5) CALCULATIONS |
|---|---------|---------------------|---------------------|--------------------------------|------------------|
| TOTAL CLAIMS | | 41 -20= | 21 | x \$ 18.00 | 378.00 |
| INDEPENDENT CLAIMS | | 12 -3= | 9 | x \$ 84.00 | 756.00 |
| MULTIPLE DEPENDENT CLAIM(S) (if applicable) | | | | +\$280.00 | 0.00 |
| BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(4): | | | | | 890.00 |
| <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO\$1,040 | | | | | |
| <input checked="" type="checkbox"/> International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO.....\$ 890 | | | | | |
| <input type="checkbox"/> International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO...\$ 740 | | | | | |
| <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provision of PCT Article 33(1)-(4).....\$ 710 | | | | | |
| <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2) to (4)\$ 100 | | | | | |
| Surcharge of \$130 for furnishing the National fee or oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 mos. from the earliest claimed priority date (37 CFR 1.482(e)). | | | | | 0.00 |
| | | | | TOTAL OF ABOVE CALCULATIONS | 2,024.00 |
| Reduction by 1/2 for filing by small entity, if applicable. Affidavit must be filed also. (Note 37 CFR 1.9, 1.27, 1.28.) | | | | | |
| | | | | SUBTOTAL | 2,024.00 |
| Processing fee of \$130 for furnishing the English Translation later than [] 20 [] 30 mos. from the earliest claimed priority date (37 CFR 1.482(f)). | | | | | |
| | | | | TOTAL NATIONAL FEE | 2,024.00 |
| Fee for recording the enclosed assignment (37 CFR 1.21(h)). | | | | | + 40.00 |
| | | | | TOTAL FEES ENCLOSED | 2,064.00 |

- a. ☒ A check in the amount of \$2,064.00 to cover the above fees is enclosed.
b. ☐ Please charge my Deposit Account No. 19-3935 in the Amount of \$ to cover the above fees. A duplicate copy of this sheet is enclosed.
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-3935. A duplicate copy of this sheet is enclosed.



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PATENT TRADEMARK OFFICE

SUBMITTED BY: STAAS & HALSEY LLP

| | | | |
|-----------|-----------------------------|----------|--------|
| Type Name | Richard A. Gollhofer | Reg. No. | 31,106 |
| Signature | <i>Richard A. Gollhofer</i> | Date | 3/1/02 |

Docket No.: 1454.1218

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Josef BAUER et al.

Serial No.

Group Art Unit:

Confirmation No.

Filed: (concurrently)

Examiner:

For: SYSTEM FOR DETECTING AND EVALUATING WORD SPEECH SIGNALS
REPRESENTING A WORD FROM A USER OF A SPEECH RECOGNITION SYSTEM
(as amended)

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Before examination of the above-identified application, please amend the application as follows:

IN THE TITLE:

Please DELETE the Title in its entirety and REPLACE with the following new Title.

-- SYSTEM FOR DETECTING AND EVALUATING WORD SPEECH SIGNALS
REPRESENTING A WORD FROM A USER OF A SPEECH RECOGNITION SYSTEM --.

IN THE SPECIFICATION:

Please REPLACE the pending specification with the substitute specification attached hereto.

IN THE CLAIMS:

Please cancel without prejudice or disclaimer claims 1-13 in the underlying PCT application and ADD new claims 14-54 in accordance with the following:

14. (NEW) A method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, comprising:

detecting acoustic word speech signals from a user;

carrying out a speech recognition operation using a first vocabulary;
assessing probability of correct speech recognition;
prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;
detecting and evaluating letter signals as input by the user;
carrying out a word recognition operation, after said detecting and evaluating of respective letter signals representing a single letter, using a second vocabulary larger than the first vocabulary;
assessing the probability of correct word recognition; and
terminating spelling and outputting a word obtained with a second desired probability by said assessing the probability of correct word recognition.

15. (NEW) The method as claimed in claim 14, wherein the word recognition operation includes

assigning a letter recognition probability based on the letter speech signals; and
determining a word list of all words in the second vocabulary having a letter recognition probability not lower than a highest determined letter recognition probability for any word, minus a first threshold value.

16. (NEW) The method as claimed in claim 15,
wherein said assessing the probability of correct word recognition comprises determining whether the word list contains only a single word, and
wherein said terminating spelling and outputting the word is performed if only a single word is contained in the word list.

17. (NEW) The method as claimed in claim 16,
further comprising:
carrying out speech recognition of the word speech signals using the word list with each word assigned a speech recognition probability; and
determining whether a highest speech recognition probability and a second highest speech recognition probability differ from one another by a predetermined threshold value; and
wherein if the predetermined threshold value is exceeded by a difference between the highest and second highest speech recognition probabilities, said terminating

spelling and outputting the word is performed for the word in the word list with the highest speech recognition probability.

18. (NEW) A method for detecting and evaluating word speech signals representing a word from the user of a speech recognition system, comprising:

- detecting acoustic word speech signals from a user;
- carrying out a speech recognition operation;
- assessing probability of correct speech recognition;
- prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;
- detecting and evaluating letter signals as input by the user;
- carrying out a word recognition operation, after said detecting and evaluating of respective letter signals representing a single letter;
- assessing the probability of correct word recognition;
- terminating spelling and outputting a word obtained with a second desired probability by said assessing the probability of correct word recognition; and
- carrying out speech recognition of the word speech signals using the letter signals as detected and evaluated, if the correct word recognition is not obtained with the second desired probability.

19. (NEW) A method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, comprising:

- detecting acoustic word speech signals from a user;
- carrying out a speech recognition operation to obtain a speech recognition probability;
- assessing probability of correct speech recognition;
- prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;
- detecting and evaluating letter signals as input by the user of at least one letter, to obtain a letter recognition probability based on each detected letter signal;
- carrying out a word recognition operation, after said detecting and evaluating of respective letter signals representing a single letter, based on a combined recognition probability using the letter recognition probability and the speech recognition probability;
- assessing the probability of correct word recognition; and

terminating spelling and outputting a word if the word is obtained with a second desired probability by said assessing the probability of correct word recognition.

20. (NEW) The method as claimed in claim 19, further comprising generating a word list based on the combined recognition probability.

21. (NEW) The method as claimed in claim 20, wherein said terminating spelling and outputting the word is based solely on a single interrogation as to whether the combined recognition probability is the second desired recognition probability.

22. (NEW) The method as claimed in claim 21, wherein said terminating spelling and outputting the word includes

outputting an appropriate message to the user; and

terminating said detecting of the acoustic word speech signals.

23. (NEW) The method as claimed in claim 22, further comprising, after said detecting and evaluating of the letter speech signals respectively representing a letter:

determining whether the user is continuing to speak;

continuing said detecting and evaluating and the word recognition operation for next speech signals respectively representing a letter, if the user continues to speak; and

outputting one of the word list and a predetermined number of the words with highest probabilities in the word list, if the user does not continue to speak.

24. (NEW) A device for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, comprising:

speech detection means for detecting acoustic word speech signals from a user;

initial speech recognition means for carrying out a speech recognition operation using a first vocabulary;

speech assessment means for assessing probability of correct speech recognition;

means for prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;

letter detection means for detecting and evaluating letter signals as input by the user;

word recognition means for carrying out a word recognition operation, after said letter detection means has evaluated respective letter signals representing a single letter, using a second vocabulary larger than the first vocabulary;

word assessment means for assessing the probability of correct word recognition; and

termination means for terminating spelling and outputting a word obtained with a second desired probability by said word assessment means.

25. (NEW) The device as claimed in claim 24, wherein said word recognition means includes

means for assigning a letter recognition probability based on the letter speech signals; and

means for determining a word list of all words in the second vocabulary having a letter recognition probability not lower than a highest determined letter recognition probability for any word, minus a first threshold value.

26. (NEW) The device as claimed in claim 25,

wherein said word assessment means comprises means for determining whether the word list contains only a single word, and

wherein said termination means terminates spelling and outputs the word if only a single word is contained in the word list.

27. (NEW) The device as claimed in claim 26,

further comprising:

supplemental speech recognition means for carrying out speech recognition of the word speech signals using the word list with each word assigned a speech recognition probability; and

means for determining whether a highest speech recognition probability and a second highest speech recognition probability differ from one another by a predetermined threshold value; and

wherein if the predetermined threshold value is exceeded by a difference between the highest and second highest speech recognition probabilities, said termination means terminates spelling and outputs the word in the word list with the highest speech recognition probability.

28. (NEW) A device for detecting and evaluating word speech signals representing a word from the user of a speech recognition system, comprising:

speech detection means for detecting acoustic word speech signals from a user;

initial speech recognition means for carrying out a speech recognition operation;

speech assessment means for assessing probability of correct speech recognition;

means for prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;

letter detection means for detecting and evaluating letter signals as input by the user;

word recognition means for carrying out a word recognition operation, after said letter detection means has evaluated respective letter signals representing a single letter;

word assessment means for assessing the probability of correct word recognition;

termination means for terminating spelling and outputting a word obtained with a second desired probability by said word assessment means; and

supplemental speech means for carrying out speech recognition of the word speech signals using the letter signals as detected and evaluated, if the correct word recognition is not obtained with the second desired probability.

29. (NEW) A device for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, comprising:

speech detection means for detecting acoustic word speech signals from a user;

speech recognition means for carrying out a speech recognition operation to obtain a speech recognition probability;

speech assessment means for assessing probability of correct speech recognition;

means for prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;

letter detection means for detecting and evaluating letter signals as input by the user of at least one letter, to obtain a letter recognition probability based on each detected letter signal;

word recognition means for carrying out a word recognition operation, after said letter detection means has evaluated respective letter signals representing a single letter, based on a combined recognition probability using the letter recognition probability and the speech recognition probability;

word assessment means for assessing the probability of correct word recognition; and

termination means for terminating spelling and outputting a word if the word is obtained with a second desired probability by said word assessment means.

30. (NEW) The device as claimed in claim 29, further comprising means for generating a word list based on the combined recognition probability.

31. (NEW) The device as claimed in claim 30, wherein said termination means bases termination of spelling and outputting of the word on a single interrogation as to whether the combined recognition probability is the second desired recognition probability.

32. (NEW) The device as claimed in claim 31, wherein said termination means comprises:

means for outputting an appropriate message to the user; and

means for terminating detection of the acoustic word speech signals.

33. (NEW) The device as claimed in claim 32, further comprising:

means for determining whether the user is continuing to speak;

means for continuing the detection, the evaluation and the word recognition operation for next speech signals respectively representing a letter, if the user continues to speak; and

means for outputting one of the word list and a predetermined number of the words with highest probabilities in the word list, if the user does not continue to speak.

34. (NEW) A communication device for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, comprising:

a data bus;

at least one memory device, coupled to said data bus, to store at least one vocabulary and at least one program;

a speech recognition processor, coupled to said data bus, to detect acoustic word speech signals from a user and to carry out a speech recognition operation using a first vocabulary;

a speech output device, coupled to said data bus, to produce audio signals simulating speech; and

a central processor, coupled to said data bus, to assess probability of correct speech recognition, to generate first output signals causing said speech output device to prompt the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability, to evaluate letter signals as input by the user, to carry out a word recognition operation following evaluation of respective letter signals representing a single letter using a second vocabulary larger than the first vocabulary, to assess the probability of correct word recognition, and to terminate the evaluation of respective letter signals and generate second output signals causing said speech output device to output a word obtained with a second desired probability based upon assessment of the probability of correct word recognition.

35. (NEW) The communication device as claimed in claim 34, wherein said central processor also assigns a letter recognition probability based on the letter speech signals and determines a word list of all words in the second vocabulary having a letter recognition probability not lower than a highest determined letter recognition probability for any word, minus a first threshold value.

36. (NEW) The communication device as claimed in claim 35, wherein said central processor assesses the probability of correct word recognition by determining whether the word list contains only a single word, and terminates spelling and causes output of the word if only a single word is contained in the word list.

37. (NEW) The communication device as claimed in claim 36, wherein said central processor also carries out speech recognition of the word speech signals using the word list with each word assigned a speech recognition probability and determines whether a highest speech recognition probability and a second highest speech recognition probability differ from one another by a predetermined threshold value, and, if the predetermined threshold value is exceeded by a difference between the highest and second highest speech recognition

probabilities, said central processor terminates spelling and causes output of the word in the word list with the highest speech recognition probability.

38. (NEW) A communication device for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, comprising:

- a data bus;

- at least one memory device, coupled to said data bus, to store at least one program;

- a speech recognition processor, coupled to said data bus, to detect acoustic word speech signals from a user and to carry out a speech recognition operation;

- a speech output device, coupled to said data bus, to produce audio signals simulating speech; and

- a central processor, coupled to said data bus, to assess probability of correct speech recognition, to generate first output signals causing said speech output device to prompt the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability, to evaluate letter signals as input by the user, to carry out a word recognition operation following evaluation of respective letter signals representing a single letter, to assess the probability of correct word recognition, to terminate the evaluation of respective letter signals and generate second output signals causing said speech output device to output a word obtained with a second desired probability based upon assessment of the probability of correct word recognition, and to carry out speech recognition of the word speech signals using the letter signals as detected and evaluated, if the correct word recognition is not obtained with the second desired probability.

39. (NEW) A communication device for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, comprising:

- a data bus;

- at least one memory device, coupled to said data bus, to store at least one program;

- a speech recognition processor, coupled to said data bus, to detect acoustic word speech signals from a user and to carry out a speech recognition operation;

- a speech output device, coupled to said data bus, to produce audio signals simulating speech; and

a central processor, coupled to said data bus, to assess probability of correct speech recognition, to generate first output signals causing said speech output device to prompt the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability, to evaluate letter signals as input by the user, to carry out a word recognition operation following evaluation of respective letter signals representing a single letter based upon assessment of a combined recognition probability using the letter recognition probability and the speech recognition probability, to assess the probability of correct word recognition, and to terminate the evaluation of respective letter signals and generate second output signals causing said speech output device to output a word obtained with a second desired probability based on the assessment of the combined recognition probability.

40. (NEW) The communication device as claimed in claim 39, wherein said central processor also generates a word list based on the combined recognition probability.

41. (NEW) The communication device as claimed in claim 40, wherein said central processor terminates spelling and causes output of the word based solely on a single interrogation as to whether the combined recognition probability is the second desired recognition probability.

42. (NEW) The communication device as claimed in claim 41, wherein upon terminating spelling and outputting the word, said central processor also outputs an appropriate message to the user and terminates detection of the acoustic word speech signals.

43. (NEW) The communication device as claimed in claim 42, wherein, after detection and evaluation of the letter speech signals respectively representing a letter, said central processor also determines whether the user is continuing to speak, and if the user continues to speak the next speech signals respectively representing a letter are detected; while if the user does not continue to speak, said central processor causes outputting of one of the word list and a predetermined number of the words with highest probabilities in the word list.

44. (NEW) The communication device as claimed in claim 43, wherein said communication device is connectable to telephone lines,
further comprising a switching unit coupled to the telephone lines and said data bus.

45. (NEW) An electronically readable data medium storing at least one computer program to control a processor to perform a method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, said method comprising:

- detecting acoustic word speech signals from a user;
- carrying out a speech recognition operation using a first vocabulary;
- assessing probability of correct speech recognition;
- prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;
- detecting and evaluating letter signals as input by the user;
- carrying out a word recognition operation, after said detecting and evaluating of respective letter signals representing a single letter, using a second vocabulary larger than the first vocabulary;
- assessing the probability of correct word recognition; and
- terminating spelling and outputting a word obtained with a second desired probability by said assessing the probability of correct word recognition.

46. (NEW) The electronically readable data medium as claimed in claim 45, wherein the word recognition operation includes

- assigning a letter recognition probability based on the letter speech signals; and
- determining a word list of all words in the second vocabulary having a letter recognition probability not lower than a highest determined letter recognition probability for any word, minus a first threshold value.

47. (NEW) The electronically readable data medium as claimed in claim 46, wherein said assessing the probability of correct word recognition comprises determining whether the word list contains only a single word, and wherein said terminating spelling and outputting the word is performed if only a single word is contained in the word list.

48. (NEW) The electronically readable data medium as claimed in claim 47, wherein said method further comprises:

carrying out speech recognition of the word speech signals using the word list with each word assigned a speech recognition probability; and

determining whether a highest speech recognition probability and a second highest speech recognition probability differ from one another by a predetermined threshold value; and

wherein if the predetermined threshold value is exceeded by a difference between the highest and second highest speech recognition probabilities, said terminating spelling and outputting the word is performed for the word in the word list with the highest speech recognition probability.

49. (NEW) An electronically readable data medium storing at least one computer program to control a processor to perform a method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, said method comprising:

detecting acoustic word speech signals from a user;

carrying out a speech recognition operation;

assessing probability of correct speech recognition;

prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;

detecting and evaluating letter signals as input by the user;

carrying out a word recognition operation, after said detecting and evaluating of respective letter signals representing a single letter;

assessing the probability of correct word recognition;

terminating spelling and outputting a word obtained with a second desired probability by said assessing the probability of correct word recognition; and

carrying out speech recognition of the word speech signals using the letter signals as detected and evaluated, if the correct word recognition is not obtained with the second desired probability.

50. (NEW) An electronically readable data medium storing at least one computer program to control a processor to perform a method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, said method comprising:

detecting acoustic word speech signals from a user;

carrying out a speech recognition operation to obtain a speech recognition probability;

assessing probability of correct speech recognition;

prompting the user to spell out each word for which the probability of correct speech recognition does not reach a first desired probability;

detecting and evaluating letter signals as input by the user of at least one letter, to obtain a letter recognition probability based on each detected letter signal;

carrying out a word recognition operation, after said detecting and evaluating of respective letter signals representing a single letter, based on a combined recognition probability using the letter recognition probability and the speech recognition probability;

assessing the probability of correct word recognition; and

terminating spelling and outputting a word if the word is obtained with a second desired probability by said assessing the probability of correct word recognition.

51. (NEW) The electronically readable data medium as claimed in claim 50, wherein said method further comprises generating a word list based on the combined recognition probability.

52. (NEW) The electronically readable data medium as claimed in claim 51, wherein said terminating spelling and outputting the word is based solely on a single interrogation as to whether the combined recognition probability is the second desired recognition probability.

53. (NEW) The electronically readable data medium as claimed in claim 52, wherein said terminating spelling and outputting the word includes

outputting an appropriate message to the user; and

terminating said detecting the acoustic word speech signals.

54. (NEW) The electronically readable data medium as claimed in claim 53, wherein said method further comprises, after said detecting and evaluating of the letter speech signals respectively representing a letter:

determining whether the user is continuing to speak, and if the user continues to speak the next speech signals respectively representing a letter are detected; and

outputting one of the word list and a predetermined number of the words with highest probabilities in the word list, if the user is not continuing to speak.

IN THE ABSTRACT:

Please DELETE the Abstract in its entirety and replace with the attached Substitute Abstract.

REMARKS

This Preliminary Amendment is submitted to improve the form of the English translation as filed. It is respectfully requested that this Preliminary Amendment be entered in the above-referenced application.

In accordance with the foregoing, claims 1-13 have been canceled and claims 14-54 have been added. Thus, claims 14-54 are pending and are under consideration.

A substitute specification is also being filed herewith. The substitute specification is accompanied by a marked-up copy of the original specification.

If there are any questions regarding these matters, such questions can be addressed by telephone to the undersigned. Otherwise, an early action on the merits is respectfully solicited.

If any further fees are required in connection with the filing of this Preliminary Amendment, please charge same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: 3/1/02

By: Richard A. Gollhofer
Richard A. Gollhofer
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SUBSTITUTE SPECIFICATION

TITLE OF THE INVENTION

SYSTEM FOR DETECTING AND EVALUATING WORD SPEECH SIGNALS REPRESENTING
A WORD FROM A USER OF A SPEECH RECOGNITION SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and hereby claims priority to German Application No. 19942172.2 filed on September 3, 1999 in, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] The invention relates to a method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, having the following steps:

- detecting the acoustic word speech signal,
- carrying out a speech recognition operation and assessing the probability of correct speech recognition, and
- if the speech recognition does not reach the desired probability, the user is prompted to spell out the word, and
- detecting and evaluating the letter speech signals spelt out by the user.

[0003] Such a method is known from "Strategies for name recognition in automatic directory assistance systems", Andreas Kellner et al., in 'IEEE Workshop on interactive Voice Technology for Telecommunications Applications (IVTTA), pages 21-26, Turin, Italy, September 1998. A speech recognition system for a telephone network that has a word mode and a spelling mode is described therein. In the word mode, a word is input coherently by being spoken. In the spelling mode, a word is input by spelling out. If a word is not recognized in the word mode with a satisfactory recognition probability, a switchover is made into the spelling mode, in which the word is input by spelling out. Owing to the change into the spelling mode, the word mode can be based on a program that is relatively simple and quick to execute, and it is possible nevertheless to achieve a very high recognition rate, since in the case of all words not recognized exactly, the exact word is input in the spelling mode. However, the price for this high

recognition rate is the user-unfriendly spelling out, which lasts substantially longer than when the corresponding word is uttered coherently.

SUMMARY OF THE INVENTION

[0004] It is an object of the invention to develop the methods of the prior art in a more user friendly fashion.

[0005] The methods according to the invention are distinguished by the following steps:

- carrying out a word recognition operation after the respective detection of the letter speech signals representing a single letter, and
- assessing the probability of correct word recognition, and
- if a word is obtained with the desired probability with the aid of the word recognition, the spelling process is terminated and the word is output.

[0006] In the case of the method according to the invention, an attempt is therefore made to determine the word to be detected as early as after the spelling out of each letter and, if a word is obtained with the desired detection probability, the further spelling process is terminated and the word is output. As a result, the spelling process, which is bothersome for a user, is reduced to a minimum such that the user-friendliness of the method is substantially enhanced by comparison with the known method, and yet an optimal recognition rate is achieved.

[0007] According to a preferred embodiment, a speech recognition operation with the aid of which the word speech signals representing a word from a user, which signals are uttered coherently, is executed on the basis of a smaller vocabulary than in the case of the word recognition operation with the aid of which the letter speech signals representing the individual letters are evaluated. As a result, the computational outlay on the speech recognition operation can be substantially reduced by comparison with a speech recognition operation that takes account of all possible words that may occur. A quick response of the method according to the invention is achieved thereby.

[0008] According to a further preferred embodiment, a renewed speech recognition of the word speech signals is executed in the case of the word recognition operation with the aid of which the letter speech signals are evaluated, the results obtained by the evaluation of the letter speech signals being taken into account in this case. This is performed, for example, by virtue

of the fact that the letter speech signals are used to draw up a word list that is used as vocabulary during the renewed speech recognition.

[0009] The method according to the invention is ended upon termination of the spelling process, and the user of the speech recognition system is output a message to the effect that the spelling process is ended, or the word detected by the word recognition is imparted to him. However, it is also possible for only a predetermined dialog to be continued between the user and the speech recognition system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] These and other objects and advantages of the present invention will become more apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

Fig. 1 is a flowchart of the essential steps of the method according to the invention,

Fig. 2 is a flowchart of the detection and evaluation of the letter speech signals spelt out by the user,

Fig. 3 is a graph indicating how many letters must be spelt on average in order to achieve a predetermined acceptance rate, and

Fig. 4 is a block diagram of a device for executing the method according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0011] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0012] The method according to the invention is explained below in more detail with the aid of an exemplary embodiment that is a constituent of an automatic directory inquiry service and which has an automatic speech recognition system for recognizing all German town names.

[0013] 22,077 town names are listed in all German telephone books. These 22,077 words therefore constitute the total vocabulary that contains all town names to be determined with the aid of the speech recognition system.

[0014] Acoustic word speech signals from a user are detected in a step S1 (Fig. 1). The word speech signals are acoustic signals that reproduce a word in a normal, coherent mode of utterance. The words are town names in the present exemplary embodiment.

[0015] The word speech signals detected are evaluated by a speech recognition operation. Such speech recognition operations are known per se. They are used to generate a recognition result that comprises a word or a list of words, the probability of a correct speech recognition being determined in relation to each word and assigned to the respective word.

[0016] A check is made in step S3 as to whether the speech recognition operation was able to determine a word with the desired speech recognition probability. If this is the case, the word determined in step S4, which is a town name in the present exemplary embodiment, is output and the method according to the invention is ended.

[0017] If, by contrast, the result of step S3 is that no word could be determined with the required speech recognition probability, the method sequence goes over to step S5 with the aid of which a spelling process is executed in which the word to be determined is input through spelling out by the user and then evaluated appropriately. The spelling process is explained in more detail below.

[0018] The word determined in step S5 is output in step S6, and the method is ended.

[0019] In the exemplary embodiment relating to detecting and evaluating a town name, the speech recognition is not executed on the basis of the total vocabulary of 22,077 town names, but only on the basis of a medium vocabulary of approximately 1,000 to 5,000 town names. This vocabulary that is considerably reduced by comparison with the total vocabulary includes the town names most frequently asked for. The computer power required to run a computer program for speech recognition can be substantially diminished by the reduction in the vocabulary. The desired town name can be determined very quickly and with a high recognition rate for a majority of the queries because of the reduced vocabulary.

[0020] Since the speech recognition S2 is connected downstream of the spelling process S5, the requirement placed on the probability of a correct speech recognition can be set very high, since a town name incorrectly recognized by the speech recognition can be input again into the spelling process, and a rejection in step S3 does not result in negative effects on the overall result of the method according to the invention.

[0021] The requirements placed on the probability of a correct speech recognition are expediently set so high that the rate of the words that are erroneously recognized in step S2 and are, however, evaluated as correctly recognized in step S3 is smaller than 3% and preferably smaller than 1%.

[0022] The spelling process in accordance with step S5 is illustrated with its individual steps in a flowchart in Fig. 2.

[0023] The user is prompted to fill out the town name in step S7. The user is prompted to spell out the letters individually in the present exemplary embodiment.

[0024] The letter speech signals, which represent an individual letter, are detected and recognized in step S8.

[0025] A word list is drawn up in step S9 in accordance with the letter signals detected and evaluated in step S8. This word list is drawn up on the basis of the total vocabulary of all 22,077 town names, the individual town names being assigned letter recognition probabilities. The letter recognition probability is the probability with which one or more spelt out letters of the word are correctly recognized with the aid of the detected and evaluated letter signals.

[0026] If, for example, the first letter spelt out by the user is a "B", all the town names that begin with a "B" are assigned high letter recognition probabilities. Furthermore, all the town names that start with a "W" are also assigned relatively high letter recognition probabilities, since a "B" and a "W" sound very similar in German, and the "W" can therefore be recognized with a relatively high probability as a correct letter for the detected and evaluated letter signals of the spelt out "B". Town names that begin with another letter are therefore assigned substantially lower letter recognition probabilities. However, only the town names whose letter recognition probability is not lower than the highest determined letter recognition probability minus a predetermined threshold value SW1 are accepted in the word list. The remaining town names are not taken into account in the following steps. The method thereby applied for determining the word list is based on the Viterbi algorithm.

[0027] The list therefore includes all town names that begin with a "B" or a "W" in the case of the input of a "B" as first letter.

[0028] A check is made in the next step S10 as to whether the list includes only a single town name. If this is the case, the method sequence is transferred in step S11 to the main method in

accordance with Fig. 1, where the town name determined is then output in step S6, and the spelling process is terminated.

[0029] If, however, the word list includes a plurality of town names, the method sequence branches to step S12, in which case a speech recognition of the originally input word speech signals is executed anew, the speech recognition being based on the word list drawn up in step S9 as vocabulary. Since the speech recognition is based on the same word speech signals as in step S2, the same speech recognition probabilities are determined for the same words. This step differs from the speech recognition according to step S2 by virtue of the new vocabulary that has been determined from the spelt out letters. The town names newly added by contrast with the vocabulary originally used in step S2 are firstly assigned a speech recognition probability. The speech recognition probability determined by the speech recognition according to step S12 is not combined with the letter recognition probability determined according to the letter recognition of step S8.

[0030] However, it is also possible to combine these two recognition probabilities as an alternative. They can be combined with one another by multiplication, for example.

[0031] A check is made in the next step S13 as to whether the highest speech recognition probability for a town name is higher than the second highest speech recognition probability of a further town name in the word list by a predetermined threshold value SW2. If this is the case, the method sequence branches to step S14 at which the method sequence is transferred again to the main method in which the town name with the highest speech recognition probability is output and the spelling process is terminated. If the highest speech recognition probability is not higher than the next highest speech recognition probability by the predetermined threshold value SW2, the method sequence goes over to step S15 in which the user is output a signal for speaking the next letter, and a pause is made for uttering the next letter. The signal is a short sound signal, for example.

[0032] A check is made in step S16 as to whether the user is speaking a further letter. If the user speaks a further letter, the method sequence goes over again to step S6 at which the further letter is detected and recognized. A loop transversal with the steps S8, S9, S10, S11 or S12, S13, S14 or S15 and S16 is thereby begun.

[0033] As in the first loop transversal, a new word list is drawn up in the case of each further loop transversal in step S9. For this purpose, the individual town names are again assigned a letter recognition probability. This letter recognition probability is determined on the basis of the recognition probabilities with which the individual letters of the town names have been correctly recognized by the detected and evaluated letter signals. The letter recognition probability is calculated by multiplying all the recognition probabilities of the sequence of spelt out letters of the town names for which a corresponding sequence of letter signals has been detected and evaluated. This calculation is executed in such a way that the letter recognition probability previously determined in step S8 is combined with, that is to say multiplied by, the letter recognition probability for the execution of step S8 in the preceding loop transversal.

[0034] Again, included in the word list are only the town names whose letter recognition probability is not lower than the highest determined letter recognition probability minus a predetermined threshold value SW1. The remaining town names are not taken into account in the following steps, that is to say a new list is drawn up, individual town names not being taken into account by comparison with the previous list, and others being included anew. However, a tendency arises in this case in accordance with which the number of the words in the word list is reduced with each loop transversal, since the recognition is the more specific the more letter signals are detected and evaluated.

[0035] In the case of a plurality of transversals of the loop, the word list is reduced solely as determined by the letters input during spelling out, and the interrogation of step S10 is therefore based solely on the letter recognition probability.

[0036] This loop is transversed until, as a result of one of the two interrogations in steps S10 and S13, a town name has been determined with the required recognition probability. If steps S10 and S13 do not lead to termination of the loop, but a termination of the loop ensues in step S16, that is to say because it is established that the user is no longer speaking, the method sequence goes over to step S17 with which either the word that has the highest recognition probability, or a residual list having, for example, the three to ten words on the word list that have been assigned the highest recognition probabilities, is output.

[0037] Illustrated in Fig. 3 is a diagram showing how many letters have to be spelt out on average, that is to say how many loop transversals must be executed until a predetermined acceptance rate is reached. Illustrated by dashes in the diagram is the result for the method

according to the invention, which has two termination criteria at steps S10 and S13. The result for a conventional method without such termination criteria is drawn with a continuous line. It may be seen from this diagram that, for example, after 7 letters have been spelt out an acceptance rate of only just above 40% is achieved with the known spelling methods, whereas an acceptance rate of over 80% is already achieved with the method according to the invention. Substantially fewer letters need be spelt out with the method according to the invention than is the case for conventional spelling methods. This diagram also shows that acceptance rates of 80% to 100% are already achieved with the spelling out of six letters.

[0038] Consequently, the method according to the invention can be used to limit the average number of letters to be spelt out to five to seven.

[0039] A successful recognition rate was already achieved for an average number of 4.9 letters with the aid of the described exemplary embodiment for detecting and evaluating the town names of Germany.

[0040] The present invention is not limited to the automatic detection and recognition of town names, but is suitable, in particular, for all vocabularies with a limited number of words. It can, however, also be used for unlimited vocabularies. The method is then to be modified in a way known per se such that when words that are not yet included in the total vocabulary are being input by spelling them out a routine is executed with the aid of which these words are added to the total vocabulary.

[0041] The method according to the invention can also be modified in such a way that the individual words are assigned a combined recognition probability on the basis of the letter and speech recognition. In this case, the word list is drawn up on the basis of the combined recognition probability. As a consequence of this, the two recognition probabilities of the above described exemplary embodiment, on which the termination criteria according to steps S10 and S13 are based, are identical, for which reason one termination criterion can be deleted.

[0042] According to a simplified method, it is also possible at each loop traversal only to remove words from a word list once drawn up. Since no new words can be added thereby, the speech recognition of step S12 need be executed only the once during the first loop traversal, since town names set forth in the list have all been evaluated already with the corresponding speech recognition probability.

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[0043] In the above exemplary embodiment, the letters are uttered in isolation when being spelt out, and are respectively recognized individually. However, it is also possible for the letters to be uttered continuously when being spelt out. In the case of such a continuous method, step S15 (signal for the next letter and pause) can be eliminated.

[0044] Figure 4 shows a device, specifically a telephone communication system 1 for an automatic directory inquiry service. The telephone communication system 1 is designed as a digitally operating telephone communication system having an internal databus 2, a central processor unit 3, a memory unit 4, a speech recognition unit 5 and a speech output unit 6. Connected to the databus 2 is a switching unit 7 via which the analog and digital telephone lines 8, 9 can be switched to connect to the units 3 to 6 via the databus 2. Telephone terminals 10 are connected to the telephone lines 8, 9, it being possible for one or more exchanges 11 to be connected there between.

[0045] A user can select the telephone communication system 1 at one of the telephone terminals 10, by which means he is connected to the units 3 to 6 via the switching unit 7 and the databus 2.

[0046] A plurality of computer programs are stored in the memory unit 4. One of these is provided for executing the above described exemplary embodiment for recognizing town names. If, in his dialog with the telephone communication system, the user reaches a point at which the town name needs to be input, an appropriate prompt is output to the user by the speech output unit 6, and the user then speaks a town name. The latter is then detected with the aid of the speech recognition unit 5 and evaluated in accordance with the above described method, the user being prompted, if required, to spell out the town name.

[0047] Since the method according to the invention is not limited to the recognition of town names, a plurality of programs that operate in accordance with the method according to the invention can be provided, these programs each being capable of recognizing words of specific vocabularies, for example personal names and company names, numbers, stocks or the like. These computer programs designed according to the invention are called up and controlled by a higher level dialog control program.

[0048] These computer programs can also be stored on an electronically readable data medium and, for example, can be transmitted to another telephone communication system.

[0049] The invention has been described in detail with particular reference to preferred embodiments thereof and examples, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

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ABSTRACT

METHOD FOR DETECTING AND EVALUATING WORD SPEECH SIGNALS REPRESENTING A WORD FROM A USER OF A SPEECH RECOGNITION SYSTEM

In the event of a possibly incorrect speech recognition, the user is prompted to spell out the corresponding word. After each spelt-out word, word recognition is executed such that the spelling process can be terminated given a satisfactory recognition probability.

MARKED-UP COPY OF SUBSTITUTE SPECIFICATION

[Description] TITLE OF THE INVENTION

[METHOD] SYSTEM FOR DETECTING AND EVALUATING WORD SPEECH SIGNALS
REPRESENTING A WORD FROM A USER OF A SPEECH RECOGNITION SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and hereby claims priority to German Application No. 19942172.2 filed on September 3, 1999 in, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] The invention relates to a method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, having the following steps:

- detecting the acoustic word speech signal,
- carrying out a speech recognition operation and assessing the probability of correct speech recognition, and
- if the speech recognition does not reach the desired probability, the user is prompted to spell out the word, and
- detecting and evaluating the letter speech signals spelt out by the user.

[0003] Such a method is known from "Strategies for name recognition in automatic directory assistance systems", Andreas Kellner et al., in 'IEEE Workshop on interactive Voice Technology for Telecommunications Applications (IVTTA), pages 21-26, Turin, Italy, September 1998. A speech recognition system for a telephone network that has a word mode and a spelling mode is described therein. In the word mode, a word is input coherently by being spoken. In the spelling mode, a word is input by spelling out. If a word is not recognized in the word mode with a satisfactory recognition probability, a switchover is made into the spelling mode, in which the word is input by spelling out. Owing to the change into the spelling mode, the word mode can be based on a program that is relatively simple and quick to execute, and it is possible nevertheless to achieve a very high recognition rate, since in the case of all words not recognized exactly, the exact word is input in the spelling mode. However, the price for this high

recognition rate is the user-unfriendly spelling out, which lasts substantially longer than when the corresponding word is uttered coherently.

SUMMARY OF THE INVENTION

[0004] It is [therefore the] an object of the invention to develop the [method mentioned at the beginning] methods of the prior art in a more user friendly fashion. [The object is achieved by a method having the features of claim 1. Advantageous refinements of the invention are specified in the subclaims.]

[0005] The [method] methods according to the invention [is] are distinguished by the following steps:

- carrying out a word recognition operation after the respective detection of the letter speech signals representing a single letter, and
- assessing the probability of correct word recognition, and
- if a word is obtained with the desired probability with the aid of the word recognition, the spelling process is terminated and the word is output.

[0006] In the case of the [method] methods according to the invention, an attempt is therefore made to determine the word to be detected as early as after the spelling out of each letter and, if a word is obtained with the desired detection probability, the further spelling process is terminated and the word is output. As a result, the spelling process, which is bothersome for a user, is reduced to a minimum such that the user-friendliness of the method is substantially enhanced by comparison with the known method, and yet an optimal recognition rate is achieved.

[0007] According to a preferred embodiment, a speech recognition operation with the aid of which the word speech signals representing a word from a user, which signals are uttered coherently, is executed on the basis of a smaller vocabulary than in the case of the word recognition operation with the aid of which the letter speech signals representing the individual letters are evaluated. As a result, the computational outlay on the speech recognition operation can be substantially reduced by comparison with a speech recognition operation that takes account of all possible words that may occur. A quick response of the method according to the invention is achieved thereby.

[0008] According to a further preferred embodiment, a renewed speech recognition of the word speech signals is executed in the case of the word recognition operation with the aid of which the letter speech signals are evaluated, the results obtained by the evaluation of the letter speech signals being taken into account in this case. This is performed, for example, by virtue of the fact that the letter speech signals are used to draw up a word list that is used as vocabulary during the renewed speech recognition.

[0009] The method according to the invention is ended upon termination of the spelling process, and the user of the speech recognition system is output a message to the effect that the spelling process is ended, or the word detected by the word recognition is imparted to him. However, it is also possible for only a predetermined dialog to be continued between the user and the speech recognition system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] [The] These and other objects and advantages of the present invention [is explained below in more detail with the aid of an exemplary embodiment illustrated in the drawing. In] will become more apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

Fig. 1 [shows] is a flowchart of the essential steps of the method according to the invention, [in a flowchart]

Fig. 2 [shows] is a flowchart of the detection and evaluation of the letter speech signals spelt out by the user, [in a flowchart,]

Fig. 3 [shows a diagram] is a graph indicating how many letters must be spelt on average in order to achieve a predetermined acceptance rate, and

Fig. 4 [shows] is a block diagram of a device for executing the method according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0011] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0012] The method according to the invention is explained below in more detail with the aid of an exemplary embodiment that is a constituent of an automatic directory inquiry service and which has an automatic speech recognition system for recognizing all German town names.

[0013] 22,077 town names are listed in all German telephone books. These 22,077 words therefore constitute the total vocabulary that contains all town names to be determined with the aid of the speech recognition system.

[0014] Acoustic word speech signals from a user are detected in a step S1 ([figure] Fig. 1). The word speech signals are acoustic signals that reproduce a word in a normal, coherent mode of utterance. The words are town names in the present exemplary embodiment.

[0015] The word speech signals detected are evaluated by [means of] a speech recognition operation. Such speech recognition operations are known per se. They are used to generate a recognition result that comprises a word or a list of words, the probability of a correct speech recognition being determined in relation to each word and assigned to the respective word.

[0016] A check is made in step S3 as to whether the speech recognition operation was able to determine a word with the desired speech recognition probability. If this is the case, the word determined in step S4, which is a town name in the present exemplary embodiment, is output and the method according to the invention is ended.

[0017] If, by contrast, the result of step S3 is that no word could be determined with the required speech recognition probability, the method sequence goes over to step S5 with the aid of which a spelling process is executed in which the word to be determined is input through spelling out by the user and then evaluated appropriately. The spelling process is explained in more detail below.

[0018] The word determined in step S5 is output in step S6, and the method is ended.

[0019] In the exemplary embodiment relating to detecting and evaluating a town name, the speech recognition is not executed on the basis of the total vocabulary of 22,077 town names, but only on the basis of a medium vocabulary of approximately 1,000 to 5,000 town names. This vocabulary that is considerably reduced by comparison with the total vocabulary includes the town names most frequently asked for. The computer power required to run a computer program for speech recognition can be substantially diminished by the reduction in the vocabulary. The desired town name can be determined very quickly and with a high recognition rate for a majority of the queries because of the reduced vocabulary.

[0020] Since the speech recognition S2 is connected downstream of the spelling process S5, the requirement placed on the probability of a correct speech recognition can be set very high,

since a town name incorrectly recognized by the speech recognition can be input again into the spelling process, and a rejection in step S3 does not result in negative effects on the overall result of the method according to the invention.

[0021] The requirements placed on the probability of a correct speech recognition are expediently set so high that the rate of the words that are erroneously recognized in step S2 and are, however, evaluated as correctly recognized in step S3 is smaller than 3% and preferably smaller than 1%.

[0022] The spelling process in accordance with step S5 is illustrated with its individual steps in a flowchart in [figure] Fig. 2.

[0023] The user is prompted to fill out the town name in step S7. The user is prompted to spell out the letters individually in the present exemplary embodiment.

[0024] The letter speech signals, which represent an individual letter, are detected and recognized in step S8.

[0025] A word list is drawn up in step S9 in accordance with the letter signals detected and evaluated in step S8. This word list is drawn up on the basis of the total vocabulary of all 22,077 town names, the individual town names being assigned letter recognition probabilities. The letter recognition probability is the probability with which one or more spelt out letters of the word are correctly recognized with the aid of the detected and evaluated letter signals.

[0026] If, for example, the first letter spelt out by the user is a "B", all the town names that begin with a "B" are assigned high letter recognition probabilities. Furthermore, all the town names that start with a "W" are also assigned relatively high letter recognition probabilities, since a "B" and a "W" sound very similar in German, and the "W" can therefore be recognized with a relatively high probability as a correct letter for the detected and evaluated letter signals of the spelt out "B". Town names that begin with another letter are therefore assigned substantially lower letter recognition probabilities. However, only the town names whose letter recognition probability is not lower than the highest determined letter recognition probability minus a predetermined threshold value SW1 are accepted in the word list. The remaining town names are not taken into account in the following steps. The method thereby applied for determining the word list is based on the Viterbi algorithm.

[0027] The list therefore includes all town names that begin with a "B" or a "W" in the case of the input of a "B" as first letter.

[0028] A check is made in the next step S10 as to whether the list includes only a single town name. If this is the case, the method sequence is transferred in step S11 to the main method in accordance with [figure] Fig. 1, where the town name determined is then output in step S6, and the spelling process is terminated.

[0029] If, however, the word list includes a plurality of town names, the method sequence branches to step S12, in which case a speech recognition of the originally input word speech signals is executed anew, the speech recognition being based on the word list drawn up in step S9 as vocabulary. Since the speech recognition is based on the same word speech signals as in step S2, the same speech recognition probabilities are determined for the same words. This step differs from the speech recognition according to step S2 by virtue of the new vocabulary that has been determined from the spelt out letters. The town names newly added by contrast with the vocabulary originally used in step S2 are firstly assigned a speech recognition probability. The speech recognition probability determined by the speech recognition according to step S12 is not combined with the letter recognition probability determined according to the letter recognition of step S8.

[0030] However, it is also possible to combine these two recognition probabilities as an alternative. They can be combined with one another by [means of] multiplication, for example.

[0031] A check is made in the next step S13 as to whether the highest speech recognition probability for a town name is higher than the second highest speech recognition probability of a further town name in the word list by a predetermined threshold value SW2. If this is the case, the method sequence branches to step S14 at which the method sequence is transferred again to the main method in which the town name with the highest speech recognition probability is output and the spelling process is terminated. If the highest speech recognition probability is not higher than the next highest speech recognition probability by the predetermined threshold value SW2, the method sequence goes over to step S15 in which the user is output a signal for speaking the next letter, and a pause is made for uttering the next letter. The signal is a short sound signal, for example.

[0032] A check is made in step S16 as to whether the user is speaking a further letter. If the user speaks a further letter, the method sequence goes over again to step S6 at which the further letter is detected and recognized. A loop transversal with the steps S8, S9, S10, S11 or S12, S13, S14 or S15 and S16 is thereby begun.

[0033] As in the first loop transversal, a new word list is drawn up in the case of each further loop transversal in step S9. For this purpose, the individual town names are again assigned a letter recognition probability. This letter recognition probability is determined on the basis of the recognition probabilities with which the individual letters of the town names have been correctly recognized by the detected and evaluated letter signals. The letter recognition probability is calculated by multiplying all the recognition probabilities of the sequence of spelt out letters of the town names for which a corresponding sequence of letter signals has been detected and evaluated. This calculation is executed in such a way that the letter recognition probability previously determined in step S8 is combined with, that is to say multiplied by, the letter recognition probability for the execution of step S8 in the preceding loop transversal.

[0034] Again, included in the word list are only the town names whose letter recognition probability is not lower than the highest determined letter recognition probability minus a predetermined threshold value SW1. The remaining town names are not taken into account in the following steps, that is to say a new list is drawn up, individual town names not being taken into account by comparison with the previous list, and others being included anew. However, a tendency arises in this case in accordance with which the number of the words in the word list is reduced with each loop transversal, since the recognition is the more specific the more letter signals are detected and evaluated.

[0035] In the case of a plurality of transversals of the loop, the word list is reduced solely as determined by the letters input during spelling out, and the interrogation of step S10 is therefore based solely on the letter recognition probability.

[0036] This loop is transversed until, as a result of one of the two interrogations in steps S10 and S13, a town name has been determined with the required recognition probability. If steps S10 and S13 do not lead to termination of the loop, but a termination of the loop ensues in step S16, that is to say because it is established that the user is no longer speaking, the method sequence goes over to step S17 with which either the word that has the highest recognition

probability, or a residual list having, for example, the three to ten words on the word list that have been assigned the highest recognition probabilities, is output.

[0037] Illustrated in [figure] Fig. 3 is a diagram showing how many letters have to be spelt out on average, that is to say how many loop transversals must be executed until a predetermined acceptance rate is reached. Illustrated by dashes in the diagram is the result for the method according to the invention, which has two termination criteria at steps S10 and S13. The result for a conventional method without such termination criteria is drawn with a continuous line. It may be seen from this diagram that, for example, after 7 letters have been spelt out an acceptance rate of only just above 40% is achieved with the known spelling methods, whereas an acceptance rate of over 80% is already achieved with the method according to the invention. Substantially fewer letters need be spelt out with the method according to the invention than is the case for conventional spelling methods. This diagram also shows that acceptance rates of 80% to 100% are already achieved with the spelling out of six letters.

[0038] Consequently, the method according to the invention can be used to limit the average number of letters to be spelt out to five to seven.

[0039] A successful recognition rate was already achieved for an average number of 4.9 letters with the aid of the described exemplary embodiment for detecting and evaluating the town names of Germany.

[0040] The present invention is not limited to the automatic detection and recognition of town names, but is suitable, in particular, for all vocabularies with a limited number of words. It can, however, also be used for unlimited vocabularies. The method is then to be modified in a way known per se such that when words that are not yet included in the total vocabulary are being input by spelling them out a routine is executed with the aid of which these words are added to the total vocabulary.

[0041] The method according to the invention can also be modified in such a way that the individual words are assigned a combined recognition probability on the basis of the letter and speech recognition. In this case, the word list is drawn up on the basis of the combined recognition probability. As a consequence of this, the two recognition probabilities of the above described exemplary embodiment, on which the termination criteria according to steps S10 and S13 are based, are identical, for which reason one termination criterion can be deleted.

[0042] According to a simplified method, it is also possible at each loop traversal only to remove words from a word list once drawn up. Since no new words can be added thereby, the speech recognition of step S12 need be executed only the once during the first loop traversal, since town names set forth in the list have all been evaluated already with the corresponding speech recognition probability.

[0043] In the above exemplary embodiment, the letters are uttered in isolation when being spelt out, and are respectively recognized individually. However, it is also possible for the letters to be uttered continuously when being spelt out. In the case of such a continuous method, step S15 (signal for the next letter and pause) can be eliminated.

[0044] Figure 4 shows a device, specifically a telephone communication system 1 for an automatic directory inquiry service. The telephone communication system 1 is designed as a digitally operating telephone communication system having an internal databus 2, a central processor unit 3, a memory unit 4, a speech recognition unit 5 and a speech output unit 6. Connected to the databus 2 is a switching unit 7 via which the analog and digital telephone lines 8, 9 can be switched to connect to the units 3 to 6 via the databus 2. Telephone terminals 10 are connected to the telephone lines 8, 9, it being possible for one or more exchanges 11 to be connected there between.

[0045] A user can select the telephone communication system 1 at one of the telephone terminals 10, by which means he is connected to the units 3 to 6 via the switching unit 7 and the databus 2.

[0046] A plurality of computer programs are stored in the memory unit 4. One of these is provided for executing the above described exemplary embodiment for recognizing town names. If, in his dialog with the telephone communication system, the user reaches a point at which the town name needs to be input, an appropriate prompt is output to the user by [means of] the speech output unit 6, and the user then speaks a town name. The latter is then detected with the aid of the speech recognition unit 5 and evaluated in accordance with the above described method, the user being prompted, if required, to spell out the town name.

[0047] Since the method according to the invention is not limited to the recognition of town names, a plurality of programs that operate in accordance with the method according to the invention can be provided, these programs each being capable of recognizing words of specific vocabularies, for example personal names and company names, numbers, stocks or the like.

These computer programs designed according to the invention are called up and controlled by a higher level dialog control program.

[0048] These computer programs can also be stored on an electronically readable data medium and, for example, can be transmitted to another telephone communication system.

[0049] The invention has been described in detail with particular reference to preferred embodiments thereof and examples, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

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GR 99 P 2738

Description

Method for detecting and evaluating word speech signals
representing a word from a user of a speech recognition system

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The invention relates to a method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, having the following steps:

- detecting the acoustic word speech signal,
- 10 - carrying out a speech recognition operation and assessing the probability of correct speech recognition, and
- if the speech recognition does not reach the desired probability, the user is prompted to spell out the word, and
- detecting and evaluating the letter speech signals spelt out
- 15 by the user.

Such a method is known from "Strategies for name recognition in automatic directory assistance systems", Andreas Kellner et al., in 'IEEE Workshop on interactive Voice Technology for
20 Telecommunications Applications (IVTTA), pages 21-26, Turin, Italy, September 1998. A speech recognition system for a telephone network that has a word mode and a spelling mode is described therein. In the word mode, a word is input coherently by being spoken. In the spelling mode, a word is input by spelling out. If
25 a word is not recognized in the word mode with a satisfactory recognition probability, a switchover is made into the spelling mode, in which the word is input by spelling out. Owing to the change into the spelling mode, the word mode can be based on a program that is relatively simple and quick to execute, and it is
30 possible nevertheless to achieve a very high recognition rate, since in the case of all words not recognized exactly, the exact word

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is input in the spelling mode. However, the price for this high recognition rate is the user-unfriendly spelling out, which lasts substantially longer than when the corresponding word is uttered coherently.

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US 5,638,425 discloses a method for detecting and evaluating word speech signals representing a word from a user of an automatic call information service. The method has a word mode and a spelling mode. If, in the word mode, the speech recognition does not recognize an acoustic speech signal with a desired probability, the method switches over into the spelling mode and prompts the user to spell out the word, for which purpose the user spells out the entire word or parts thereof.

15 Kaspar B. et al., "Spracherkennung für großes Vokabular durch Buchstabieren" ["Speech recognition for a large vocabulary by means of spelling"], ITG Fachberichte, April 28th, 1986, pages 31-36 discloses an automatic call information service having a spelling mode that carries out a word recognition operation after the respective detection of letter speech signals representing a letter, in which case the spelling process is terminated and the word is output if a word with the desired recognition probability is obtained by the word recognition.

25 It is the object of the invention to develop said methods in a user-friendly fashion.

The object is achieved by means of methods, a device and a computer program product having the features of the independent claims. Advantageous refinements of the invention are specified in the subclaims.

The methods include the following steps:

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- carrying out a word recognition operation after the respective detection of the letter speech signals representing a single letter, and

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- assessing the probability of correct word recognition, and
- if a word is obtained with the desired probability with the aid of the word recognition, the spelling process is terminated and the word is output.

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In the case of the methods, an attempt is therefore made to determine the word to be detected as early as after the spelling out of each letter and, if a word is obtained with the desired detection probability, the further spelling process is terminated and the word is output. As a result, the spelling process, which is bothersome for a user, is reduced to a minimum such that the user-friendliness of the method is substantially enhanced by comparison with the known method, and yet an optimal recognition rate is achieved.

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Moreover, a speech recognition operation with the aid of which the word speech signals representing a word from a user, which signals are uttered coherently, is executed on the basis of a smaller vocabulary than in the case of the word recognition operation with the aid of which the letter speech signals representing the individual letters are evaluated. As a result, the computational outlay on the speech recognition operation can be substantially reduced by comparison with a speech recognition operation that takes account of all possible words that may occur. A quick response of the method according to the invention is achieved thereby.

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Alternatively or in addition, a renewed speech recognition of the word speech signals is executed in the case of the word recognition operation with the aid of which the letter speech signals are evaluated, the results obtained by the evaluation of the letter speech signals being taken into account in this case. This is performed, for example, by virtue of the fact that the letter speech signals are used to draw up a word list that is used as vocabulary during the renewed speech recognition.

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The method according to the invention is ended upon termination of the spelling process, and the user of the speech recognition system is output a message to the effect that the spelling process is ended, or the word detected by the word recognition is imparted
5 to him. However, it is also possible for only a predetermined dialog to be continued between the user and the speech recognition system.

The invention is explained below in more detail with the aid of an
10 exemplary embodiment illustrated in the drawing. In the drawings:

Fig. 1 shows the essential steps of the method according to the invention, in a flowchart,

15 Fig. 2 shows the detection and evaluation of the letter speech signals spelt out by the user, in a flowchart,

Fig. 3 shows a diagram indicating how many letters must be spelt on average in order to achieve a predetermined acceptance rate, and

5 Fig. 4 shows a device for executing the method according to the invention.

The method according to the invention is explained below in more detail with the aid of an exemplary embodiment that is a
10 constituent of an automatic directory inquiry service and which has an automatic speech recognition system for recognizing all German town names.

22,077 town names are listed in all German telephone books. These
15 22,077 words therefore constitute the total vocabulary that contains all town names to be determined with the aid of the speech recognition system.

Acoustic word speech signals from a user are detected in a step S1
20 (figure 1). The word speech signals are acoustic signals that reproduce a word in a normal, coherent mode of utterance. The words are town names in the present exemplary embodiment.

The word speech signals detected are evaluated by means of a
25 speech recognition operation. Such speech recognition operations are known per se. They are used to generate a recognition result that comprises a word or a list of words, the probability of a correct speech recognition being determined in relation to each word and assigned to the respective word.

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A check is made in step S3 as to whether the speech recognition operation was able to determine a word with the desired speech recognition probability. If this is the case, the word determined in step S4, which is a town name

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in the present exemplary embodiment, is output and the method according to the invention is ended.

If, by contrast, the result of step S3 is that no word could be
5 determined with the required speech recognition probability, the method sequence goes over to step S5 with the aid of which a spelling process is executed in which the word to be determined is input through spelling out by the user and then evaluated appropriately. The spelling process is explained in more detail
10 below.

The word determined in step S5 is output in step S6, and the method is ended.

15 In the exemplary embodiment relating to detecting and evaluating a town name, the speech recognition is not executed on the basis of the total vocabulary of 22,077 town names, but only on the basis of a medium vocabulary of approximately 1,000 to 5,000 town names. This vocabulary that is considerably reduced by comparison with
20 the total vocabulary includes the town names most frequently asked for. The computer power required to run a computer program for speech recognition can be substantially diminished by the reduction in the vocabulary. The desired town name can be determined very quickly and with a high recognition rate for a
25 majority of the queries because of the reduced vocabulary.

Since the speech recognition S2 is connected downstream of the spelling process S5, the requirement placed on the probability of a correct speech recognition can be set very high, since a town
30 name incorrectly recognized by the speech recognition can be input again into the spelling process, and a rejection in step S3 does not result in negative effects on the overall result of the method according to the invention.

The requirements placed on the probability of a correct speech
35 recognition are expediently set so high that the rate of the words that are erroneously recognized in step S2 and are, however, evaluated as correctly recognized in step S3 is smaller than 3% and preferably smaller than 1%.

The spelling process in accordance with step S5 is illustrated with its individual steps in a flowchart in figure 2.

The user is prompted to fill out the town name in step S7. The
5 user is prompted to spell out the letters individually in the present exemplary embodiment.

The letter speech signals, which represent an individual letter, are detected and recognized in step S8.

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A word list is drawn up in step S9 in accordance with the letter signals detected and evaluated in step S8. This word list is drawn up on the basis of the total vocabulary of all 22,077 town names, the individual town names being assigned letter recognition
15 probabilities. The letter recognition probability is the probability with which one or more spelt out letters of the word are correctly recognized with the aid of the detected and evaluated letter signals.

If, for example, the first letter spelt out by the user is a "B", all the town names that begin with a "B" are assigned high letter recognition probabilities. Furthermore, all the town names that start with a "W" are also assigned relatively high letter recognition probabilities, since a "B" and a "W" sound very similar in
20 German, and the "W" can therefore be recognized with a relatively high probability as a correct letter for the detected and evaluated letter signals of the spelt out "B". Town names that begin with another letter are therefore assigned substantially lower letter recognition probabilities. However, only the town names whose letter recognition probability is not lower
25 than the highest determined letter recognition probability minus a predetermined threshold value SW1 are accepted in the word list. The remaining town names are not taken into account in the following steps. The method thereby applied for determining the word list is based on the Viterbi algorithm.

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The list therefore includes all town names that begin with a "B" or a "W" in the case of the input of a "B" as first letter.

A check is made in the next step S10 as to whether the list

includes only a single town name. If this is the case, the method sequence is transferred in step S11 to the main method in accordance with figure 1, where the town name determined is then output in step S6, and the spelling process is terminated.

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If, however, the word list includes a plurality of town names, the method sequence branches to step S12, in which case a speech recognition of the originally input word speech signals is executed anew, the speech recognition being based on the word list drawn up in step S9 as vocabulary. Since the speech recognition is based on the same word speech signals as in step S2, the same speech recognition probabilities are determined for the same words. This step differs from the speech recognition according to step S2 by virtue of the new vocabulary that has been determined from the spelt out letters. The town names newly added by contrast with the vocabulary originally used in step S2 are firstly assigned a speech recognition probability. The speech recognition probability determined by the speech recognition according to step S12 is not combined with the letter recognition probability determined according to the letter recognition of step S8.

However, it is also possible to combine these two recognition probabilities as an alternative. They can be combined with one another by means of multiplication, for example.

A check is made in the next step S13 as to whether the highest speech recognition probability for a town name is higher than the second highest speech recognition probability of a further town name in the word list by a predetermined threshold value SW2. If this is the case, the method sequence branches to step S14 at which the method sequence is transferred again to the main method in which the town name with the highest speech recognition probability is output and the spelling process is terminated. If the highest speech recognition probability is not higher than the next highest speech recognition probability by the predetermined threshold value SW2, the method sequence goes over to step S15 in which the user is output a signal for speaking the next letter, and a pause is made for uttering the next letter. The signal is a

short sound signal, for example.

A check is made in step S16 as to whether the user is speaking a further letter. If the user speaks a further letter, the method
5 sequence goes over again to step S6 at which the further letter is detected and recognized. A loop transversal with the steps S8, S9, S10, S11 or S12, S13, S14 or S15 and S16 is thereby begun.

As in the first loop transversal, a new word list is drawn up in
10 the case of each further loop transversal in step S9. For this purpose, the individual town names are again assigned a letter recognition probability. This

letter recognition probability is determined on the basis of the recognition probabilities with which the individual letters of the town names have been correctly recognized by the detected and evaluated letter signals. The letter recognition probability is
5 calculated by multiplying all the recognition probabilities of the sequence of spelt out letters of the town names for which a corresponding sequence of letter signals has been detected and evaluated. This calculation is executed in such a way that the letter recognition probability previously determined in step S8 is
10 combined with, that is to say multiplied by, the letter recognition probability for the execution of step S8 in the preceding loop transversal.

Again, included in the word list are only the town names whose
15 letter recognition probability is not lower than the highest determined letter recognition probability minus a predetermined threshold value SW1. The remaining town names are not taken into account in the following steps, that is to say a new list is drawn up, individual town names not being taken into account by
20 comparison with the previous list, and others being included anew. However, a tendency arises in this case in accordance with which the number of the words in the word list is reduced with each loop transversal, since the recognition is the more specific the more letter signals are detected and evaluated.

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In the case of a plurality of transversals of the loop, the word list is reduced solely as determined by the letters input during spelling out, and the interrogation of step S10 is therefore based solely on the letter recognition probability.

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This loop is transversed until, as a result of one of the two interrogations in steps S10 and S13, a town

name has been determined with the required recognition probability. If steps S10 and S13 do not lead to termination of the loop, but a termination of the loop ensues in step S16, that is to say because it is established that the user is no longer
5 speaking, the method sequence goes over to step S17 with which either the word that has the highest recognition probability, or a residual list having, for example, the three to ten words on the word list that have been assigned the highest recognition probabilities, is output.

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Illustrated in figure 3 is a diagram showing how many letters have to be spelt out on average, that is to say how many loop transversals must be executed until a predetermined acceptance rate is reached. Illustrated by dashes in the diagram is the
15 result for the method according to the invention, which has two termination criteria at steps S10 and S13. The result for a conventional method without such termination criteria is drawn with a continuous line. It may be seen from this diagram that, for example, after 7 letters have been spelt out an acceptance rate of
20 only just above 40% is achieved with the known spelling methods, whereas an acceptance rate of over 80% is already achieved with the method according to the invention. Substantially fewer letters need be spelt out with the method according to the invention than is the case for conventional spelling methods. This diagram also
25 shows that acceptance rates of 80% to 100% are already achieved with the spelling out of six letters.

Consequently, the method according to the invention can be used to limit the average number of letters to be spelt out to five to
30 seven.

A successful recognition rate was already achieved for an average number of 4.9 letters

with the aid of the described exemplary embodiment for detecting and evaluating the town names of Germany.

5 The present invention is not limited to the automatic detection and recognition of town names, but is suitable, in particular, for all vocabularies with a limited number of words. It can, however, also be used for unlimited vocabularies. The method is then to be modified in a way known per se such that when words that are not yet included in the total vocabulary are being input by spelling
10 them out a routine is executed with the aid of which these words are added to the total vocabulary.

The method according to the invention can also be modified in such a way that the individual words are assigned a combined
15 recognition probability on the basis of the letter and speech recognition. In this case, the word list is drawn up on the basis of the combined recognition probability. As a consequence of this, the two recognition probabilities of the above described exemplary embodiment, on which the termination criteria according to steps
20 S10 and S13 are based, are identical, for which reason one termination criterion can be deleted.

According to a simplified method, it is also possible at each loop traversal only to remove words from a word list once drawn up.
25 Since no new words can be added thereby, the speech recognition of step S12 need be executed only the once during the first loop traversal, since town names set forth in the list have all been evaluated already with the corresponding speech recognition probability.

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In the above exemplary embodiment, the letters are uttered in isolation when being spelt out, and are respectively recognized individually. However, it is

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also possible for the letters to be uttered continuously when
being spelt out. In the case of such a

continuous method, step S15 (signal for the next letter and pause) can be eliminated.

Figure 4 shows a device, specifically a telephone communication system 1 for an automatic directory inquiry service. The telephone communication system 1 is designed as a digitally operating telephone communication system having an internal databus 2, a central processor unit 3, a memory unit 4, a speech recognition unit 5 and a speech output unit 6. Connected to the databus 2 is a switching unit 7 via which the analog and digital telephone lines 8, 9 can be switched to connect to the units 3 to 6 via the databus 2. Telephone terminals 10 are connected to the telephone lines 8, 9, it being possible for one or more exchanges 11 to be connected there between.

A user can select the telephone communication system 1 at one of the telephone terminals 10, by which means he is connected to the units 3 to 6 via the switching unit 7 and the databus 2.

A plurality of computer programs are stored in the memory unit 4. One of these is provided for executing the above described exemplary embodiment for recognizing town names. If, in his dialog with the telephone communication system, the user reaches a point at which the town name needs to be input, an appropriate prompt is output to the user by means of the speech output unit 6, and the user then speaks a town name. The latter is then detected with the aid of the speech recognition unit 5 and evaluated in accordance with the above described method, the user being prompted, if required, to spell out the town name.

Since the method according to the invention is not limited to the recognition of town names, a plurality

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of programs that operate in accordance with the method according to the invention can be provided, these programs each being capable of recognizing words of specific

vocabularies, for example personal names and company names, numbers, stocks or the like. These computer programs designed according to the invention are called up and controlled by a higher level dialog control program.

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These computer programs can also be stored on an electronically readable data medium and, for example, can be transmitted to another telephone communication system.

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Patent claims

1. A method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, having the following steps:
- detecting the acoustic word speech signals,
 - carrying out a speech recognition operation and assessing the probability of correct speech recognition,
 - if the speech recognition does not reach the desired probability, the user is prompted to spell out the word,
 - detecting and evaluating the letter signals spelt out by the user,
 - carrying out a word recognition operation after the respective detection of the letter signals representing a single letter,
 - assessing the probability of correct word recognition,
 - if a word is obtained with the desired probability with the aid of the word recognition, the spelling process is terminated and the word is output,
 - the speech recognition operation being executed on the basis of a smaller vocabulary than does the word recognition operation.
2. The method as claimed in claim 1, characterized in that the during the word recognition operation, a word list is drawn up in accordance with the detected letter speech signals, the words of a total vocabulary in each case being assigned a letter recognition probability on the basis of the letter speech signals, and the word list comprising all words whose letter recognition probability is not lower than the highest determined letter recognition probability of a word minus a threshold value (SW1).

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3. The method as claimed in claim 2, characterized in that a check is made as to whether the word list contains only a single word, and if only a single word is contained the latter is output and the spelling process is terminated.

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4. The method as claimed in claim 2 or 3, characterized in that a renewed speech recognition of the word speech signals is carried out in which the words of the word list are respectively assigned a speech recognition probability, and a check is made as to whether the highest and the second highest speech recognition probability differ from one another by a predetermined threshold value (SW2), and if this is the case the word of the word list with the highest speech recognition probability is output, and the spelling process is terminated.

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5. A method for detecting and evaluating word speech signals representing a word from the user of a speech recognition system, in particular as claimed in one of the preceding claims, having the following steps:

20

- detecting the acoustic word speech signals,

- carrying out a speech recognition operation and assessing the probability of correct speech recognition,

- if the speech recognition does not reach the desired probability, the user is prompted to spell out the word,

25

- detecting and evaluating the letter signals spelt out by the user,

- carrying out a word recognition operation after the respective detection of the letter signals representing a single letter,

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- assessing the probability of correct word recognition,
- if a word is obtained with the desired probability with the aid of the word recognition, the spelling process is terminated and the word is output,
- 5 and
 - a renewed speech recognition of the word speech signals is carried out taking account of the detected letter speech signals.
- 10 6. A method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system, in particular as claimed in one of the preceding claims, having the following steps:
 - detecting the acoustic word speech signals,
 - 15 - carrying out a speech recognition operation and assessing the probability of correct speech recognition,
 - if the speech recognition does not reach the desired probability, the user is prompted to spell out the word,
 - detecting and evaluating the letter signals spelt out by
 - 20 the user,
 - carrying out a word recognition operation after the respective detection of the letter signals representing a single letter,
 - assessing the probability of correct word recognition,
 - 25 - if a word is obtained with the desired probability with the aid of the word recognition, the spelling process is terminated and the word is output,
 - during the word recognition operation a letter recognition probability being determined on the basis of the detected and
 - 30 evaluated letter signals and being combined with a speech recognition probability determined on the basis of the detected and

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evaluated word speech signals to form a combined recognition probability.

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7. The method as claimed in claim 6, characterized in that a word list is drawn up in accordance with the combined recognition probability.

5 8. The method as claimed in claim 6 or 7, characterized in that a check is made solely with the aid of a single interrogation as to whether a word is obtained with the desired recognition probability, the combined recognition probability being used as recognition probability.

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9. The method as claimed in one of claims 1 to 8, characterized in that the spelling process is terminated by outputting an appropriate message to the user and by ending the method for detecting and evaluating a word.

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10. The method as claimed in one of claims 2 to 9, characterized in that when the spelling process has not yet been terminated, after the detection and evaluation of the letter speech signals respectively representing a letter, a check is made as to whether
20 the user is continuing to speak, and if he is continuing to speak the next speech signals respectively representing a letter are detected, and if the user is not continuing to speak the word list or a predetermined number of the words with the highest probability of the word list is output.

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11. A device that is set up, and has means, for carrying out a method as claimed in one of claims 1 to 10.

12. The device as claimed in claim 11, characterized in that

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5 13. A computer program product for a data processing system that contains software code sections with the aid of which a method as claimed in at least one of claims 1 to 10 can be executed on a data processing system.

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Abstract

Method for detecting and evaluating word speech signals representing a word from a user of a speech recognition system

In the event of a possibly incorrect speech recognition, the method according to the invention prompts the user to spell out the corresponding word. After each spelt-out word, word recognition is executed such that the spelling process can be terminated given a satisfactory recognition probability.

Figure 2

100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

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FIG 1

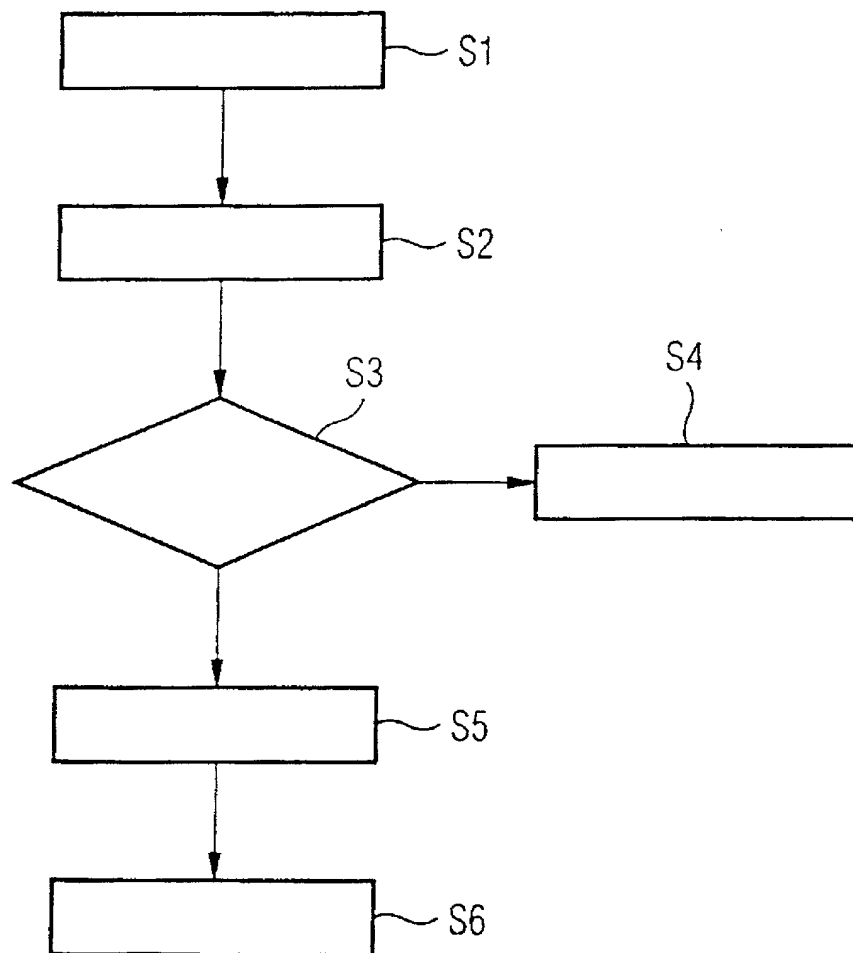
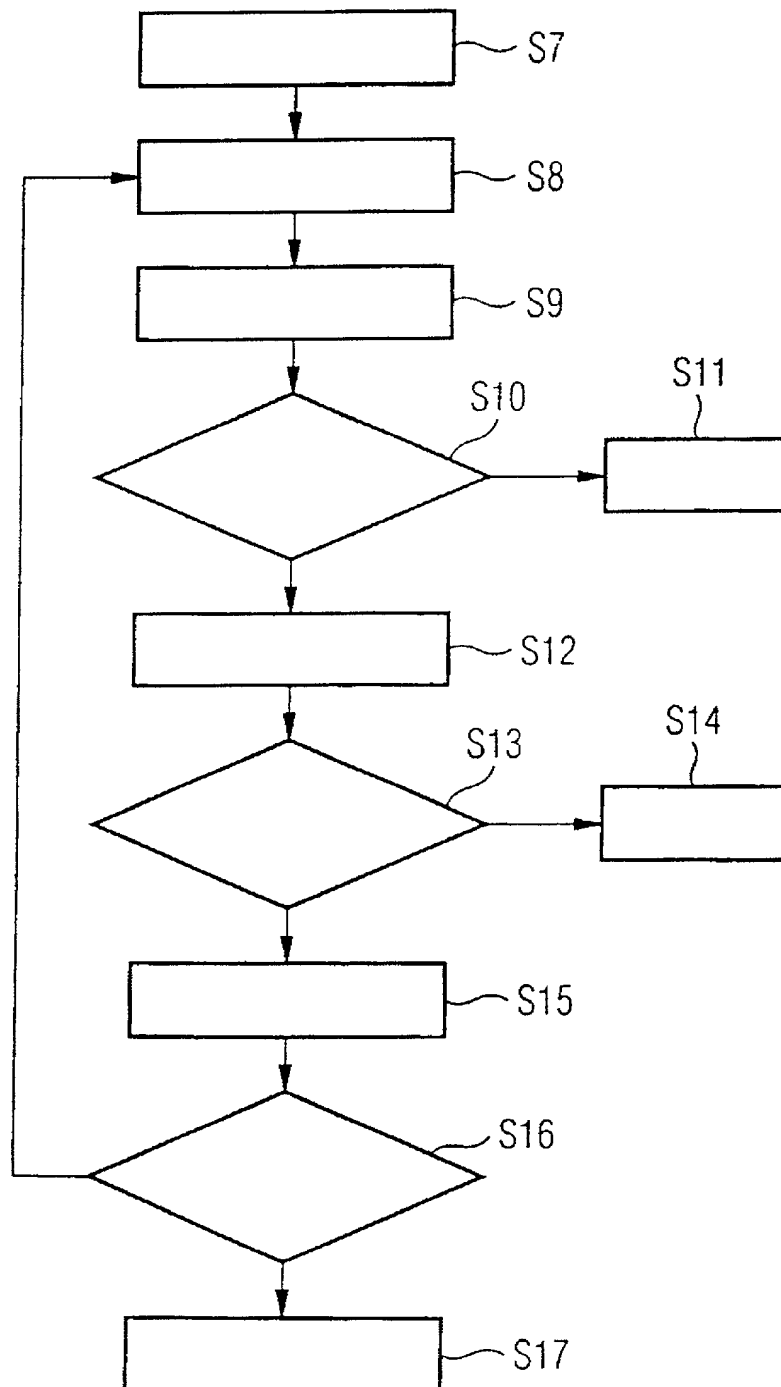
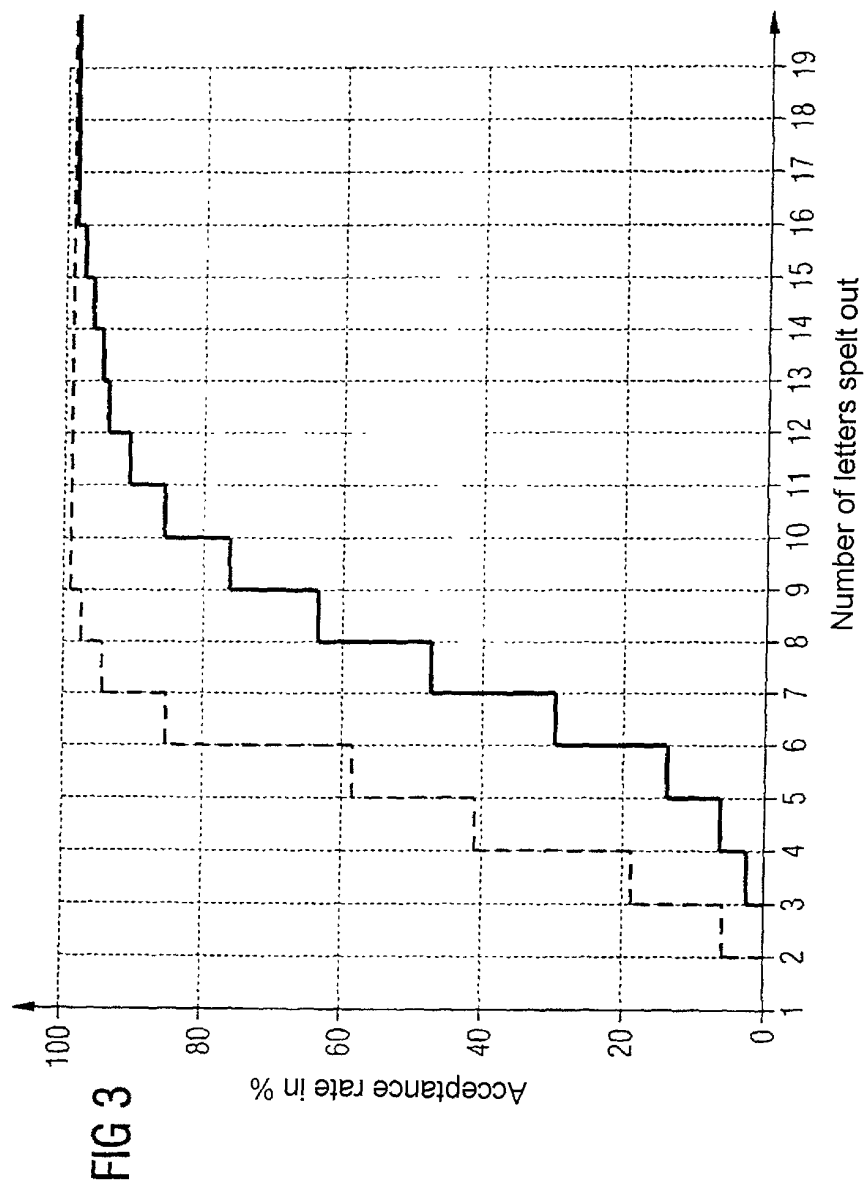


FIG 2

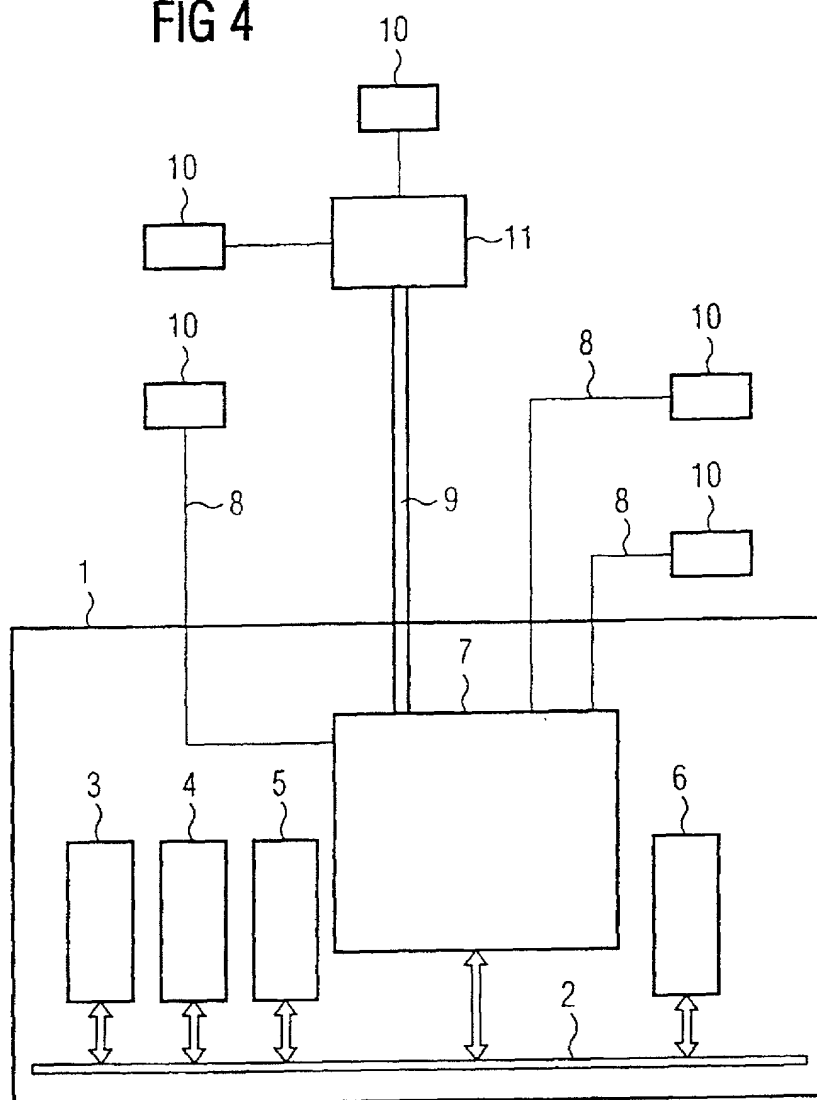


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FIG 4



Declaration and Power of Attorney For Patent Application

Erklärung Für Patentanmeldungen Mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

My residence, post office address and citizenship are as stated below next to my name,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Verfahren zum Erfassen und Auswerten
von ein Wort darstellenden
Wortsprachsignalen eines Benutzers
eines Spracherkennungssystems

Method and device for detecting and
evaluating vocal signals representing a
word emitted by a user of a voice-
recognition system

deren Beschreibung

the specification of which

(zutreffendes ankreuzen)

☐ hier beigelegt ist.

☒ am 31.05.2000 als

PCT internationale Anmeldung

PCT Anwendungsnummer PCT/DE00/01787

eingereicht wurde und am _____

abgeändert wurde (falls tatsächlich abgeändert).

(check one)

☐ is attached hereto.

☒ was filed on 31.05.2000 as

PCT international application

PCT Application No. PCT/DE00/01787

and was amended on _____

(if applicable)

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

19942172.2

DE

03.09.1999

☒

☐

(Number)

(Country)

(Day Month Year Filed)

Yes

No

(Nummer)

(Land)

(Tag Monat Jahr eingereicht)

Ja

Nein

(Number)

(Country)

(Day Month Year Filed)

☐

☐

(Nummer)

(Land)

(Tag Monat Jahr eingereicht)

Yes

No

Ja

Nein

(Number)

(Country)

(Day Month Year Filed)

☐

☐

(Nummer)

(Land)

(Tag Monat Jahr eingereicht)

Yes

No

Ja

Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/01787

(Application Serial No.)
(Anmeldeseriennummer)

31.05.2000

(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

anhängig

(Status)
(patentiert, anhängig,
aufgegeben)

pending

(Status)
(patented, pending
abandoned)

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date D,M,Y)
(Anmeldedatum T, M; J)

(Status)
(patentiert, anhängig,
aufgeben)

(Status)
(patented, pending,
abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden können, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: (Name und Registrationsnummer anführen)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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And I hereby appoint

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